

PROJECTS—HI-FI—COMPUTERS

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Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

600-MHz COUNTER

A battery-powered 600-MHz frequency counter that's small enough to fit in the palm of your hand. Build it for less than 17 cents per MHz. Turn to page 39.

VIDEO MOTORCYCLE GAME

Rev your engine, hang a wheelie, accelerate up the ramp and see how many obstacles you can jump. Construction starts on page 44.

DIGITAL CIRCUIT DESIGN

Part 2. How to design digital circuits from scratch. The walk through sequential and combinatorial circuits and circuit reduction techniques starts on page 47.

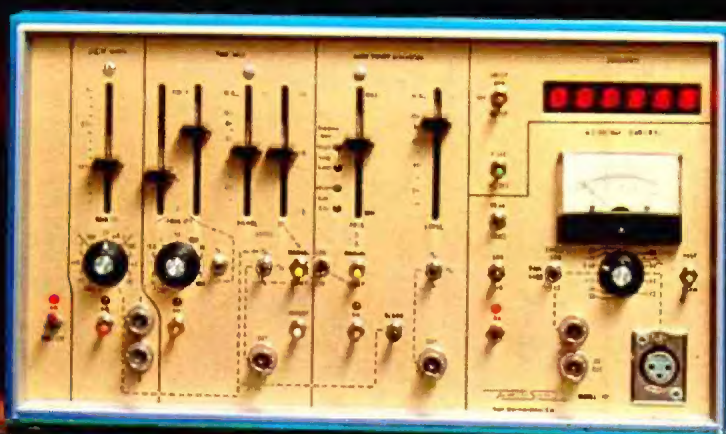
4-CHANNEL FM

A look at the different broadcast systems under consideration by the FCC and what it will mean to you. For the complete story, turn to page 51.

PLUS:

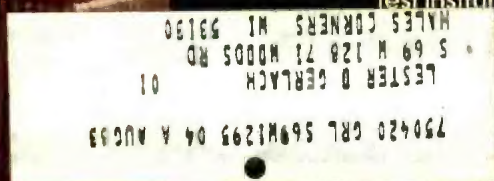
- ★ Build a NOM card for an 1802-based computer
- ★ Hobby Corner
- ★ Computer Corner
- ★ Jack Darr's Service Clinic
- ★ 2 Hi-Fi Lab Test Reports

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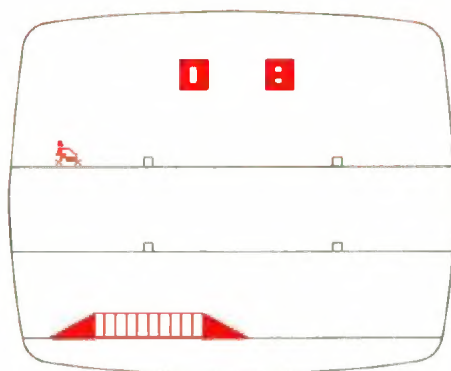


COVER STORY AUDIO TEST STATION

Professional-quality test instrument you can build combines several important test instruments into a single cabinet. Construction starts on page 35.



BUILD THIS



Video Motorcycle Game

Keep up with the advance in video game sophistication by building this single-player game for lots of fun and excitement.

L. STEVEN CHEAIRS

THIS ARCADE-QUALITY VIDEO GAME IS A follow-up to the "Tank Battle" described in the November and December issues. The heart of this game is one LSI IC that contains a complex audio sound generator, a complete timing circuit (thus allowing for unique point identification anywhere on the television screen), the motion logic, a number of ROM image arrays, chip buffering and color video circuits. The video circuit includes the horizontal and vertical blanking, the horizontal and vertical sync circuits, the color circuits, the field intensity circuit, and logic for both the American NTSC and the European PAL screen format.

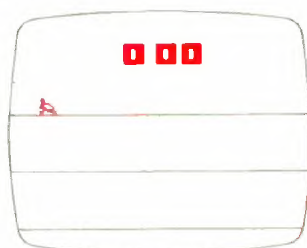
It doesn't require much imagination for the operator to find himself or herself upon the back of an iron stallion, with a faint taste of dust and a distant roar of the elated crowd; that sound is only surpassed by the mechanical snorting of the throbbing steed. With but a wrist's twitch the ultimate of freedom and adventure is realized.

This is made possible by another new dedicated IC introduced by General Instruments Corporation. There is as much difference between this game and the common pong-type units as there is between an earthworm and man. This is the second IC in a new generation of video games; the first is GI's AY-3-8710-1 battle game.

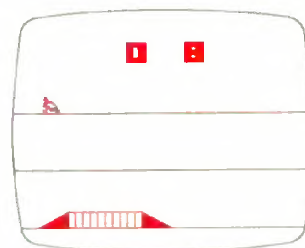
This single-player game begins when a mode of play is selected; reset is automatic when power is first turned on. Four games are provided; each with two levels of complexity. The four games are *Drag Race*, *Enduro*, *Stunt Cycle* and *Motorcross*. A single motorcycle and rider is displayed on a tri-segmented road that, in most of the games, contains obstacles that the rider must jump. As with the tank

game, realistic engine and crashing sounds are provided. As the motorcycle changes its speed or when it shifts gears,

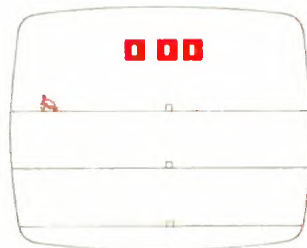
the engine sounds change to reflect these conditions. Realistic wheel rotation is displayed.



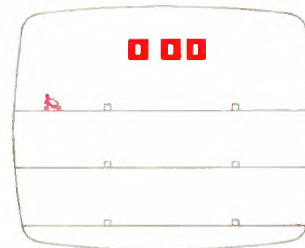
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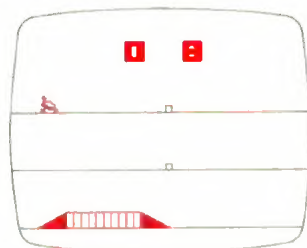
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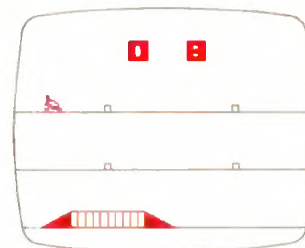
c



d



e



f

FIG. 1—TYPICAL VIDEO IMAGES as they appear on the TV screen. The Drag Race at a, Stunt Cycle at b, Motorcross, the easy way at c and the hard way at d. Enduro the easy way (e) has single obstacle on first and second rows; the hard way (f) has two obstacles in the first and second rows.

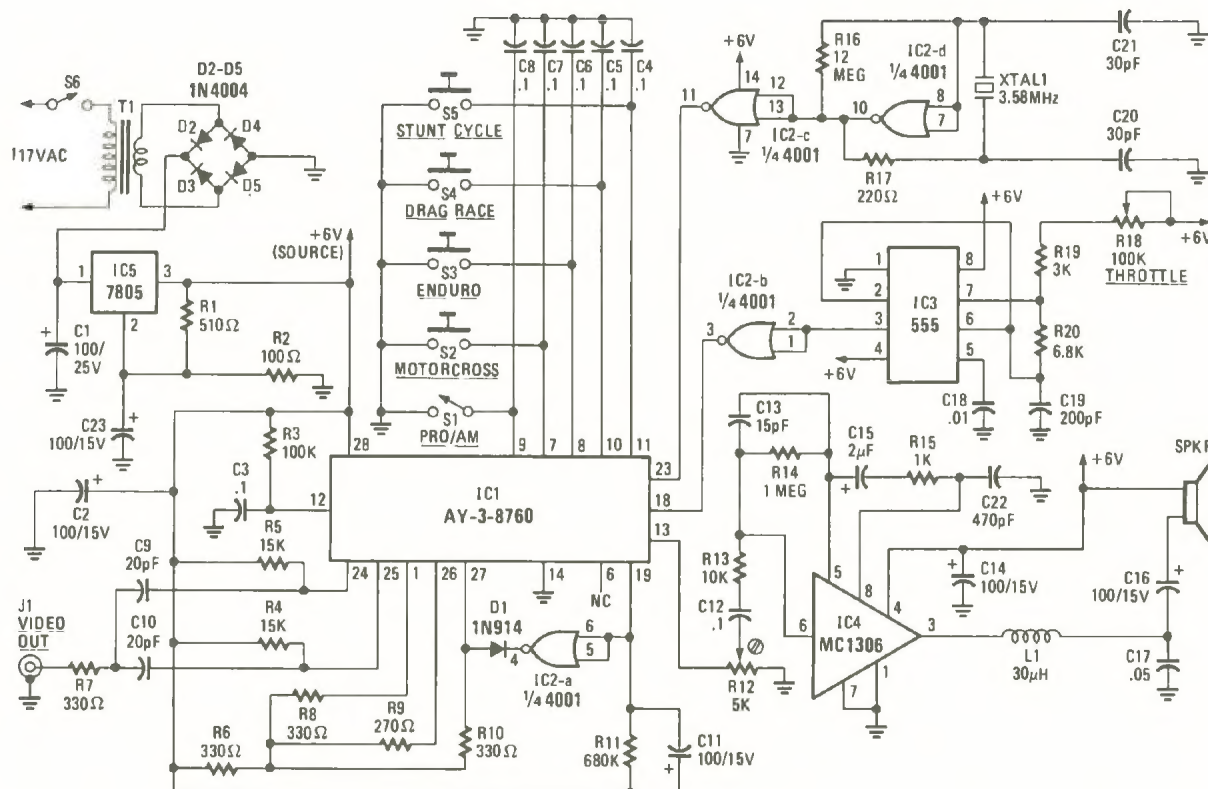


FIG. 2—SCHEMATIC OF THE MOTORCYCLE GAME. Object of the games is to traverse the three roads without accident in the shortest possible time.

PARTS LIST

All resistors 1/4 watt, 5%.

R1—510 ohms
R2—100 ohms
R3—100,000 ohms
R4, R5—15,000 ohms
R6—R8, R10—330 ohms
R9—270 ohms
R11—680,000 ohms
R12—5000 ohms trimmer pot
R13—10,000 ohms
R14—1 megohm
R15—1000 ohms
R16—12 megohms
R17—270 ohms
R18—100,000 ohms
R19—3000 ohms
R20—6800 ohms
C—100 μ F, 25 volts, electrolytic
C2, C11, C14, C16, C23—100 μ F, 15

volts, electrolytic
C3—C8, C12—0.1 μ F ceramic disc
C9, C10—20 pF
C23—15 pF
C15—2 μ F, tantalum
C17—0.05 μ F ceramic disc
C18—0.01 μ F ceramic disc
C19—200 pF
C20, C21—30 pF
C22—470 pF
L1—30 μ H RF choke
XTAL1—3.58 MHz quartz crystal
D1—1N914
D2—D5—1N4004
IC1—AY-3-8760 video game IC
IC2—4001 or 4011 CMOS quad 2-input gate
IC3—555 timer
IC4—MC1306 1/4-watt audio amplifier

IC5—7805 5-volt regulator (TO-220 case)
T1—power transformer, 12 VAC, 1A secondary
F1—1 amp fuse
S1—SPST toggle or rotary switch
S2—S5—SPST normally open pushbutton switch
S6—SPST toggle switch
SPKR1—8-16-ohm speaker, 0.25 watt or higher

The following are available from Questar Engineering Co., 50 S. McDonald St., Mesa, AZ 85202: PC board \$9.75; AY-3-8760 \$25.50; and kit of all parts listed above \$61.75. Add \$1.75 to all orders for shipping, handling and insurance.

The games begin with the rider at the top left-hand side of the screen. The cycle begins to move when the throttle pot is turned. The cycle and rider move across the first track from left to right, it exits the screen and reappears on the left side of track number two; it likewise transverse this track in the same direction and exits the screen; only to reappear on the left-hand side of track number three, which again it transverse from left to right. When it exits the screen on track number three, it is replaced at the starting position and remains stationary. The throttle must be reset to the minimum speed position and again increased. See

Fig. 1 for typical video images as seen using this game.

About the circuit

The AY-3-8760 was designed for both color and black-and-white operation using a standard domestic 525-line NTSC receiver or foreign 625-line PAL units.

The complete game unit is shown schematically in Fig. 2. In addition to automatic reset at turn-on, reset also occurs when any game is selected by pressing one of the four momentary contact SPST pushbutton switches (S2-S4). Also, an SPST switch (S1) is used to select either the pro or amateur skill level; I use a rota-

ry switch that protrudes from the left side of the case—acting as one handle bar. The THROTTLE pot protrudes from the right side of the case, thus, forming another handle bar.

Upon pressing the DRAG RACE select pushbutton the screen takes on the form as seen in Fig. 1-a. The score is automatically reset to zero upon pressing a game-select switch. The object of the Drag Race game is to reach the right side of the third (bottom) track segment in the shortest possible time, the minimum score. At the end of each game return the pot to the slow position; when it is increased again the score will be reset and

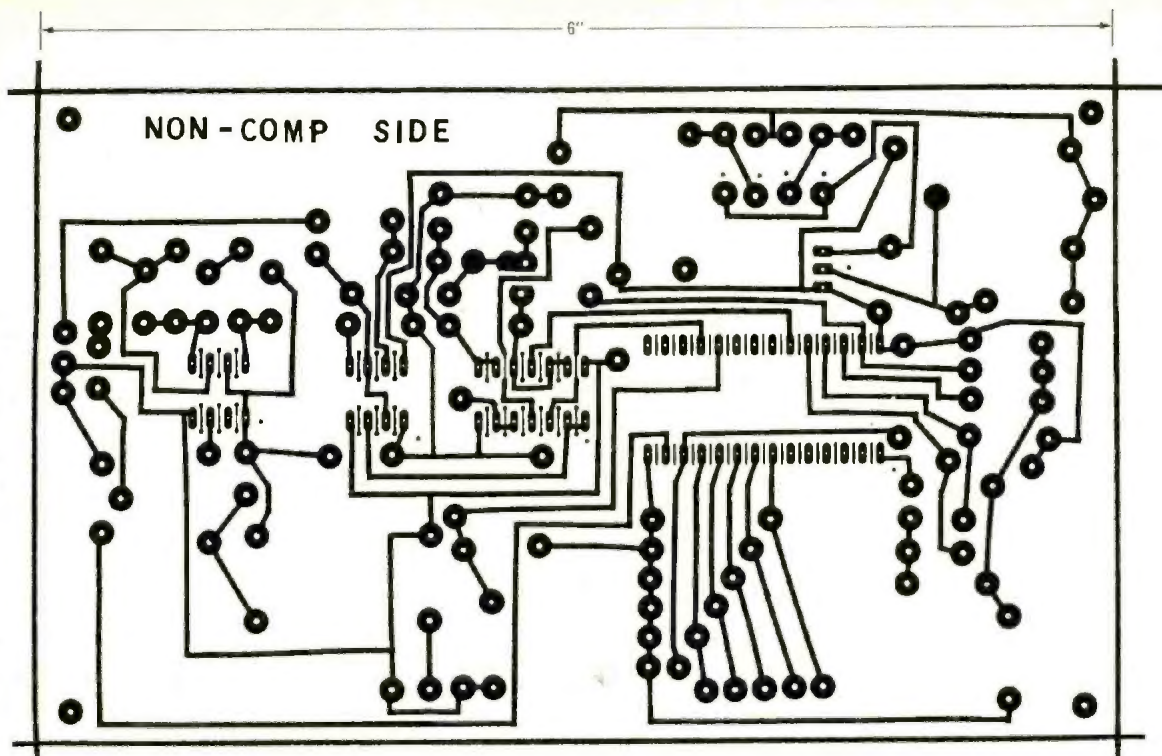


FIG. 3—FOIL PATTERN for the single-sided printed-circuit board.

a new game will begin. The score—a three-digit number centered at the top of the screen—is advanced at a fixed rate throughout the game. At the end of each game the score remains static until the beginning of the next game.

This game requires the development of speed-shifting skills in order to minimize one's score. When the game begins, the motorcycle is in low gear and will move down the track at a fixed rate. The only way the cycle may be accelerated is to shift into the next gear, by returning the throttle to a "slow" position and then turning it back to a "fast" position. The cycle now moves across the screen at a higher rate of speed. If the above process is repeated the motorcycle will shift into third gear; this results in the maximum possible velocity. Thus, a minimum score is obtained when the highest gear is obtained in the shortest period of time.

When the amateur mode is selected by the PRO/AM switch, the game proceeds just as described above. But when the professional mode is chosen, then when the user twists the throttle too rapidly, the motorcycle's front end raises off the ground and the cycle flips upside down. When a crash occurs a high-pitched screeching sound is generated. At the end of the screech the game is reset with the bike reappearing at the beginning of track 1. No crashes occur in the easy mode. If the game is being displayed on a black-and-white television set then the cycle and score are white; the track is black; and the background is gray. On a color set the cycle and score are also white. Also, the road is black; only the background is changed—it is red. For all

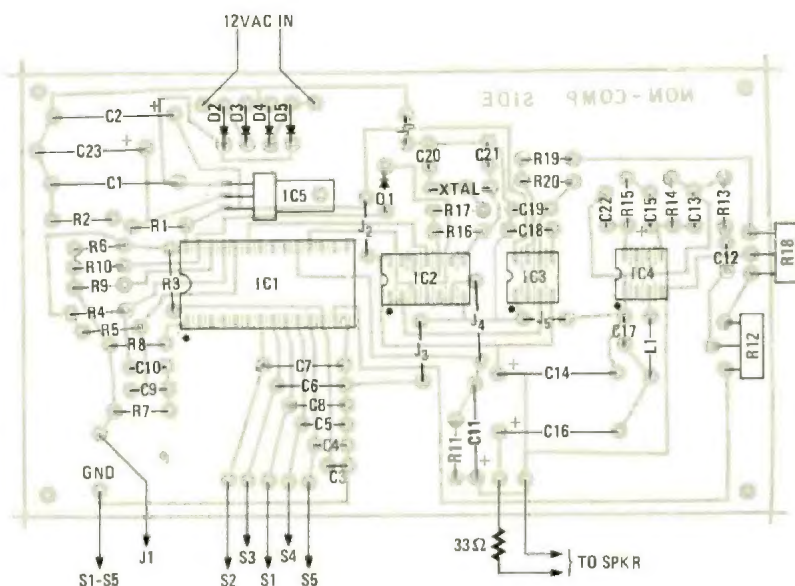


FIG. 4—HOW PARTS ARE LOCATED on the PC board. Don't overlook the five jumpers.

games included on the motorcycle-game IC only the background is in color.

Upon pressing the STUNT CYCLE select switch, the screen will be as seen in Fig. 1-b. The score is preset, the left digit is set to zero and the right digit will be an eight. The right digit (or digits as the game proceeds) equals the number of buses between the ramps. The left digit represents the number of crashes; the maximum amount possible depends on the setting of the PRO/AM switch. In the amateur mode a total of seven crashes may occur. But in the professional mode three crashes only are permitted.

Crashes can occur due to a number of factors. As in the Drag Race game, if the motorcycle is accelerated too rapidly it will flip upside down and a screeching sound is generated. Another method of crashing is to have an insufficient speed upon jumping the buses. This causes the cycle to land on either the second ramp or on one of the buses. A collision is also recorded if the cycle lands too far past the end of the last ramp and an appropriate crash sound is generated. Every time an accident occurs the left digit is advanced and the cycle and rider are placed back at

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VIDEO MOTORCYCLE GAME

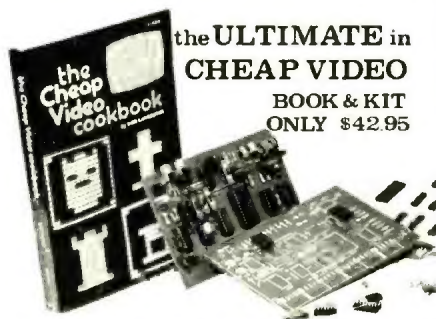
continued from page 46

the start. Every time a successful jump is made the two right-hand digits are increased by 1 and another bus is added to the area between the two ramps; also, a good-jump sound is generated. The motorcycle reappears at the starting position after each jump. The cycle, score and buses are white; the ramps and track are black. For black-and-white operation, the background is gray, and in color the background is blue.

If the PRO/AM switch is in the easy mode and the MOTORCROSS select switch depressed, then the picture will be like that shown in Fig. 1-c. The cycle moves across the screen, at a rate proportional to the setting of the throttle, as the throttle is advanced from its low-speed setting. No speed shifting exists in this game. As in the Drag Race game, the object of the game is to transverse the three track segments in the minimum amount of time. On each track segment though, there is a blockade. The operator must do a "wheelie" in order to cross over this obstacle.

In the PRO mode, two obstacles per track are displayed; see Fig. 1-d for a typical screen image. The game otherwise functions as the amateur mode did. Again, the cycle, rider, score and block-

continued on page 76



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VIDEO MOTORCYCLE GAME

continued from page 69

ades are white; the track is black. The background is gray for black-and-white operation and green on a color set.

The fourth game, Enduro, in the amateur mode appears like the image seen in Fig. 1-e. As with Motorcross the first two segments contain obstacles; the third segment resembles the Stunt Cycle game in that it contains buses and ramps. For the first two tracks "wheelies" are required to pass the blockades. Before entering the third track the throttle must be adjusted to perform the required jump across the buses. In the professional mode, two additional obstacles are added (see Fig. 1-f).

How it works

The main section is the AY-3-8760 LSI integrated circuit. Section two is a 3.58-MHz crystal clock source. The next section is a set of controls; four game select pushbuttons, one SPST mode select switch, and a 50- to 250-kHz oscillator used as the throttle control. Section four is the power supply—12 volts AC is converted to about 6 volts DC. The next section is the video output summing network. The last block is the audio amplifier.

The throttle oscillator is formed by using an LM555 timer. The frequency is set by the control potentiometer; the

output is applied to pin 18 of the AY-3-8760 via a CMOS inverter.

The 1/4-watt audio amplifier is formed from a MC1306P monolithic complementary power preamplifier/amplifier. An 8-16-ohm speaker is driven at the output of this section. A volume control trimmer pot can be adjusted for the desired volume level.

The black video (ramps, track and composite blanking) is summed to the white video (motorcycle, rider, buses, score and obstacles) along with the sync pulses. The color A and B outputs (pins 24 and 25, respectively) are pulled-up to $V_{cc} + 5$ volts, then summed together using 20-pF capacitors and fed into the resistor network. The intensity of the white video is reduced when no motion exists on the screen (the game has not been initiated). This will reduce the possibility of the TV screen being burned if the game is left on for extended periods of time. This feature is provided by R11, C11, D1 and CMOS inverter IC2-a. The output of the summing network should be fed directly to a video monitor or to a TV set through an RF modulator.

The power supply takes 12 volts AC from the power transformer secondary and develops the 6-volt DC V_{cc} supply. Four 1-ampere rectifiers are used in a full-wave bridge. A raised-ground 5-volt linear three-terminal IC voltage regulator is used. One volt is developed across

ground resistor R2. Capacitor filtering is used at the input and output of the regulator.

Construction

Before beginning construction you must decide on a method of assembly and wiring—either wire-wrap or a printed circuit. If you select the latter, you can use the foil pattern in Fig. 3.

After etching and drilling your board (or purchasing the board listed in the parts list) begin wiring by installing the five jumpers shown on Fig. 4.

The next step is to install the resistors and capacitors. Also the IC sockets if you elect to use them. Install and solder in the five diodes and the regulator IC. Be sure diode polarity is correct before soldering.

You are now ready to wire the PC board to the switches, control pot and power transformers. After making these connections, apply power to the board and check the voltage at the supply pins of IC1-IC4. If it is lower than 6 or higher than 7 volts, readjust the values of R1 and R2 to obtain the desired voltage.

Now install the IC's and the circuit should be ready for use. If problems arise, use regular troubleshooting techniques to find and correct them. I'm sure you'll have a great deal of fun and excitement with this advanced single-player video game.

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